Space Weather Technical Forecast

Issued on Thursday, 11 January 2024 at 01:12 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Ongoing likelihood of M-class flares, with a slight chance of X-class flares

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate with two M-flares observed, including an M1.9 from AR3538 at 10/2328 UTC and an M1.4 flare observed from just over the southeast limb peaking at 10/1255 UTC. There are eleven sunspot region on the disc, with frequent C-class flaring observed. Some growth has been observed in AR3538, near the northeast limb and AR3539 also on the northwest disc, with this region developing a small delta spot. Growth was also observed near the trailer of AR3541, one of a pair of sunspots in the southern centre disc and AR3546 which continued its ongoing, but slowing growth. A new region also developed in the northeast. The other six regions remained smaller and simpler, and either stable or decaying.

A couple of CMEs were observed, including a large prominence eruption from the east limb at around 10/2030 UTC, particularly impressive in SDO aia-304 and GOES SUVI-304. However none of these have Earth-directed components.

Solar Wind / Geomagnetic Activity: Solar winds, as observed by DSCOVR and ACE at L1, remained at background to slightly elevated speeds, varying between 370 km/s and 410 km/s. Density has been average or below throughout. Interplanetary magnetic field (IMF), Bt, was initially weak, but became Moderate from 10/0800 UTC, ranging 5-10nT. The north-south component, Bz, varied between +8/-8 nT. Phi angle was mostly positive (away from the Sun). Geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux is near background. GOES16 high energy (greater than 2MeV) electron flux was at background. The associated 24-hour fluence was well below Active throughout. The 11/0000 UTC observation was 1.28e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is likely to continue with further M-class flares, and a slight chance of isolated X-class flares.

Solar Wind / Geomagnetic Activity: There is a potential glancing CME arrival. This left the Sun on 09 Jan due to a filament eruption in the southeast disc, and gives a chance of a very slight glance Day 3 (13 Jan). Otherwise slow wind conditions are expected to persist with background to slightly elevated wind speeds. Quiet geomagnetic conditions are expected for much of the period, but may rise to give a spell of Unsettled with a chance of Active with any glancing CME.

Energetic Particles / Solar Radiation: High energy proton flux is forecast to continue near background through the period, but with a slight chance of seeing further increases towards the S1 minor radiation storm threshold given any notable flaring. The high energy electron flux is forecast to persist at background, with the associated 24 hour electron fluence remaining below the Active (1e8) threshold.

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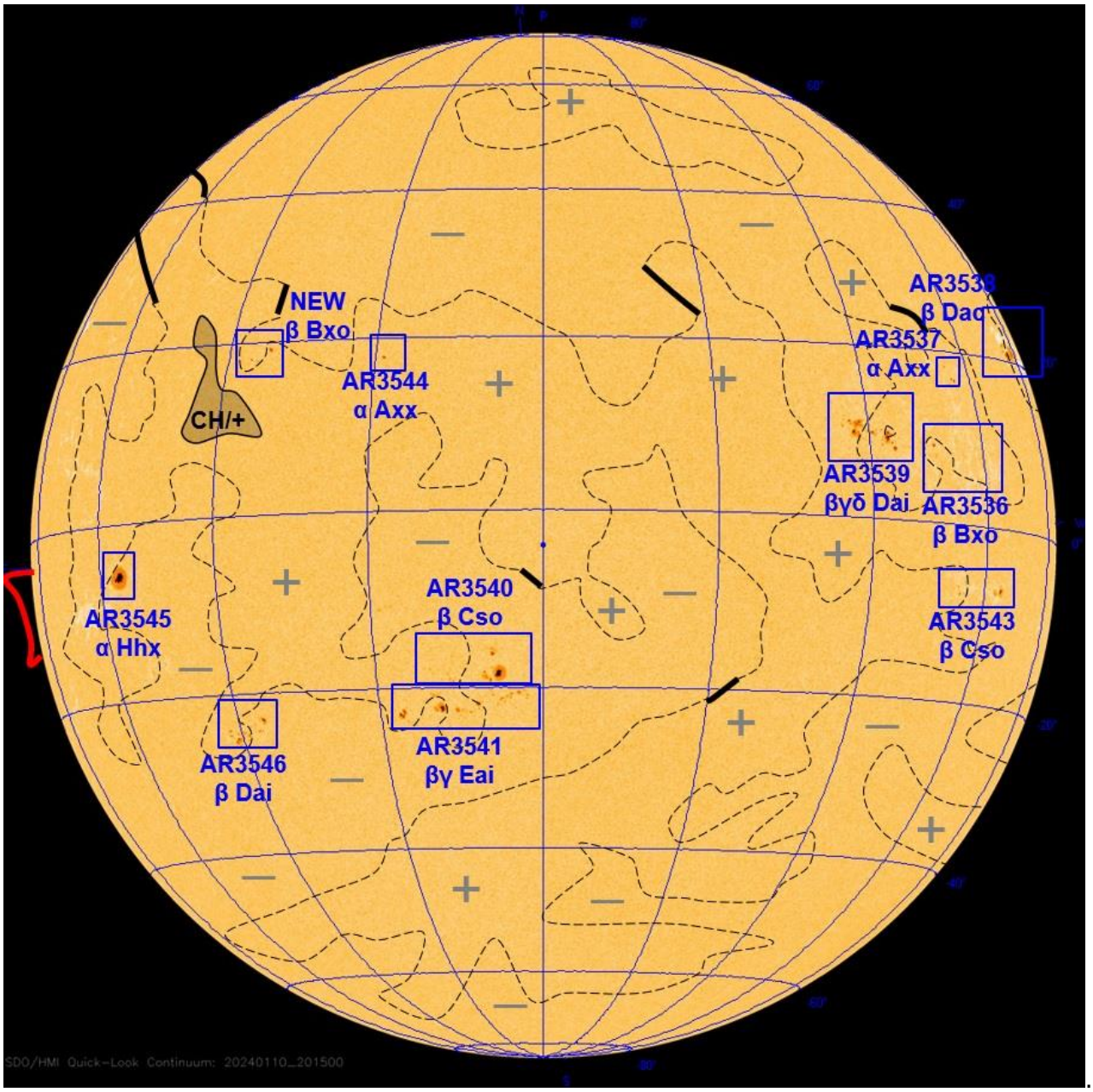
Figure 1. Solar Analysis Valid 10/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A glancing CME arrival is possible on day 3 (13 Jan), originating from a complex filament lift-off from the southeast disk on 09 Jan.

Solar wind speeds are slightly elevated to background, and expected to persist at this level with slow wind conditions persisting throughout. This is supported by MOSWOC enlil

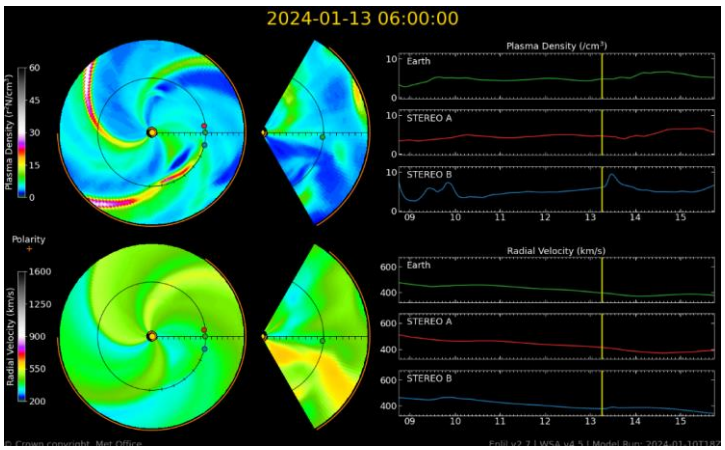
Mainly Quiet geomagnetic activity is expected to persist, with only a slight chance of isolated Unsettled intervals. Any CME glance may increase activity to give a spell of Unsettled with a chance of isolated Active intervals.

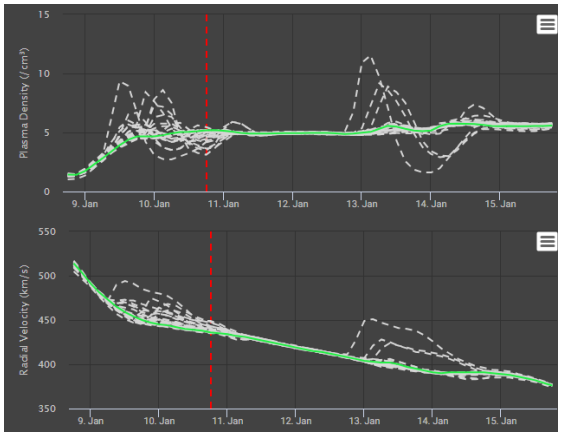
Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	5	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
09/2240 UTC	Nil	SE	Filament	530km/s	Missing	Small glance possible day 3 (13 Jan)

Figure 2: Enlil and ensemble





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Radio Blackouts - X-Ray Flares:

Moderate activity is likely, with the eleven sunspot regions currently on the disc resulting in further isolated M-flares. There is a slight chance of X-class flares, perhaps with the greatest risk from AR3538 near the limb.

In the northwest, there are two main sunspot regions of note. AR3538 is close to the limb and consequently difficult to assess, but was showing growth and increase in magnetic looping on e.g. SDO aia-171 and aia-304. AR3539 also showed some slow development, with the formation of a weak delta spot to the north of its main leader. However the other regions in the northwest are gradually declining, and these regions will disappear over the western limb through the period.

In the south AR3540 and the AR3541 form a composite and relatively wide region. The former is the more northern bipolar group that has seen decay within its trailer, while the latter has seen some growth with a pair of separating spots emerge just east of its trailer. The areal extent of the group remains small, comprised of predominately small spots, however the ongoing evolution and emergence brings additional complexity and further growth is possible. AR3546 in the southwest was a rapidly growing region, however this development has now slowed. There are further small regions on the eastern disc, while more regions likely to rotate onto the disc with recent eruptions and looping evident on e.g. SDO aia-171 from over the eastern limb.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	60	55	50
Very Active	R3 to R5 X Class	No	15	10	10	10

Figure 3a: GOES-16/18 X-ray Flux

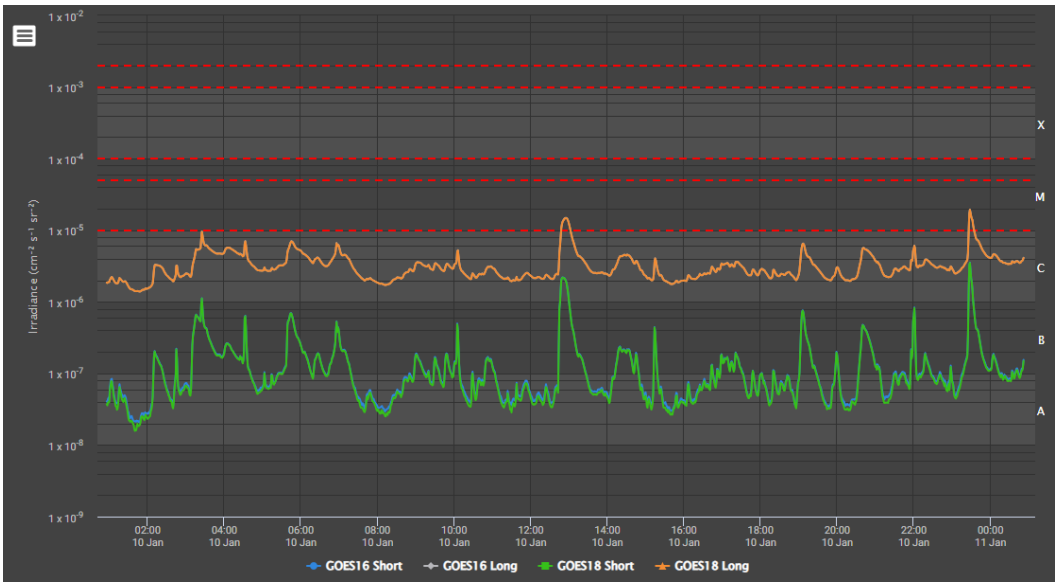

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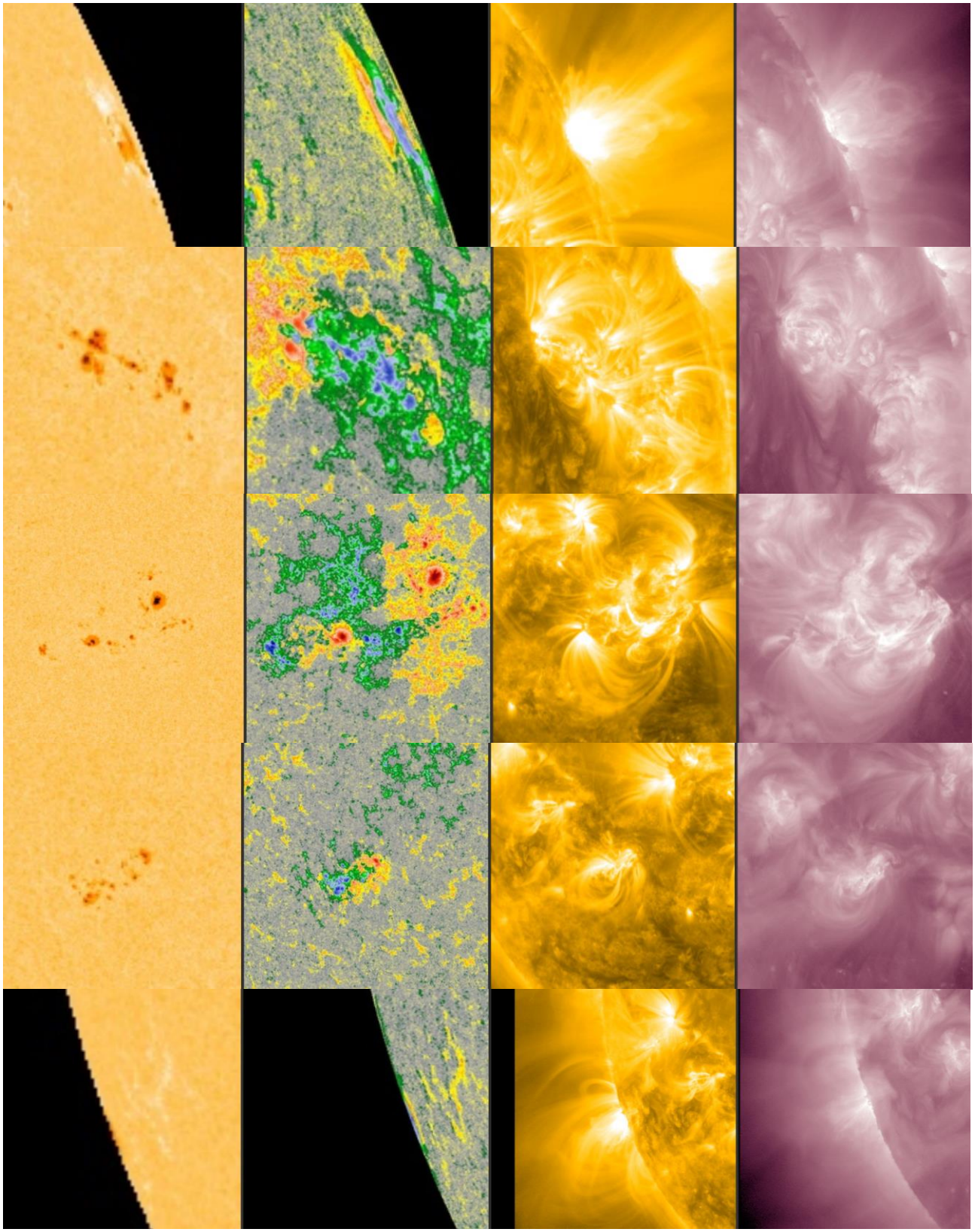
Figure 3b: SDO imagery left to right: Intensitygram, Magnetogram, aia-171, aia-211. Top to bottom: AR3538 – with significant looping over NW limb. AR3539 – with small delta spot near trailer, AR3540/41 with recent emergence near trailer, and complex looping evident, AR3546 which showed recent rapid growth although now slowed, and magnetic looping on SE disc associated with source of M1.4 flare and likely to soon rotate onto the disc.



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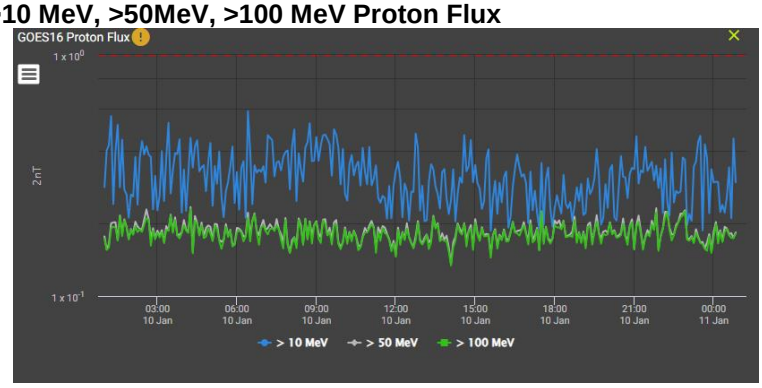
Solar Radiation Storms - (High Energy Protons):

GOES18 high energy (greater than 10MeV) proton flux has declined to a near background level after recent enhancements. Any further notable flares will bring a risk of proton flux rising again, with this risk slightly increased due to the multiple spots in the western hemispheric. This brings a slight chance of reaching the S1 Minor Radiation Storm threshold.

Please note: GOES-18 is currently being used as the primary proton instrument, with GOES-16 data currently viewed as unreliable due to a fault reported by NOAA.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: GOES-16 >10 MeV, >50MeV, >100 MeV Proton Flux



High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) as measured by GOES-16 at GEO is currently at background, and in the absence of any significant enhancement is expected to persist at this level. The associated 24 hour fluence is expected to remain below the Active threshold, with REFM output currently viewed as providing good guidance.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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